**Research & Reviews in Biotechnology & Biosciences** **ISSN No: 2321-8681**
**Website: www.biotechjournal.in** **Review article**
**Volume: 9, Issue: 2, Year: 2022** **PP: 23.31**
**DOI:** https://doi.org/10.5281/zenodo.7932908 **Peer Reviewed Journal**

# Importance of in vitro methods in the propagation of nutraceutical plants- a mini review

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*Article History*

Received: 15/08/2022
Accepted: 20/09/2022

Article ID: RRBB/152

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**Abstract**

Plants are major sources of natural products mainly used in pharmaceuticals and the food industry. Especially, nutraceuticals and medicinal plants are in great demand worldwide as these are used for food, flavorings, cosmetics, and medicinal purposes. Nowadays utilization of herbal drugs and natural products is increasing due to which economically important plant populations are reducing from the wild. Indiscriminate collection of several plants for different purposes has resulted in the extinction of several species and has pushed them in the endangered category. Therefore, in vitro culture techniques like micropropagation, callus cultures, secondary metabolite production etc. are applied for the large-scale production of plants producing active compounds. The advantage of in vitro propagation is that the plant material becomes continuously available for extraction of the desired compounds, avoiding the problems related to the collection, transport, and storage of plant products. Numerous species of nutraceutical interest like Catharanthus roseus, Mentha spp., Zingiber officinale, Ocimum basilicum, etc. have been micropropagated. In the present review, the neutraceuticals importance and in vitro methods applied for the propagation of neutraceutical important plants have been discussed.

**Keywords**: Neutraceuticals; Natural products; Secondary metabolite; Tissue culture

## 1. Introduction

Medicinal and nutraceutical plants are having high scientific value for their health-promoting properties [1]. These plants are a valuable source of herbal drugs for the world's population. Around one-quarter of the prescribed drugs contain extracts or active components present in the plant and thus there is a great demand for raw plant materials by pharmaceuticals and the food industry [2]. Presently nutraceuticals have received attention due to their nutritional, safety, and therapeutic effects. The studies

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have depicted good results for these compounds in various complications [3]. The indiscriminate harvesting of wild plants for various purposes has depleted a large population of important plants and some being of nutraceutical interest. Thus several species are now under threat. Biotechnology has played an important role in the food industry especially on the major energy-providing foods, because of the greater interest in non-nutritive components from natural products or foods. A lot of progress has occurred in the past decade in all aspects of biotechnological nutraceutical development[4,5]. Therefore, sustainable delivery of plant materials requires modern propagation techniques like tissue culture [1].

**2. Neutraceuticals and their Importance**

Nutraceutical is a term derived from "nutrition" and "pharmaceutics"[6]. The 'nutraceutical' was termed in 1979 by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine (Cranford, New Jersey).

A hybrid of nutrients and pharmaceuticals underscores the crossroads between the food and pharmaceutical industries. There is no universally accepted definition for the word ''nutraceutical'', it is mainly used as a marketing term and not for regulatory purposes [2]. It was defined as a food or part of food, that provides medical or health benefits, including the prevention and treatment of diseases [7]. Nutraceuticals range from isolated nutrients, herbal products, dietary supplements and diets to genetically engineered "designer" foods and processed products such as cereals, soups, and beverages.

Nutraceuticals are the nutritional supplements and non-specific biological therapies that contain nontoxic food components used for curing diseases, promoting wellness, preventing malignant processes as well as for health purposes other than nutrition with established nutritional functions [8,9]. It is a mineral, a vitamin, an amino acid, fatty acid, a medical herb or other botanical, or botanical products as concentrates or extracts, a dietary substance to supplement the diet by enhancing the total daily intake (Figure 1) [10,11]. Based on chemical properties, nutraceuticals are classified as Polyunsaturated fatty acids, Prebiotics , Flavonoids and Vitamins [11].

Most of the nutraceuticals contain multiple therapeutic benefits and are having physiological benefits or protection against diseases like CVD, Cancer, Diabetes, Obesity, Chronic inflammatory disorders, Parkinson's disease, Alzheimer's disease [12]. Nutraceuticals play a key role in biological processes like cell proliferation, antioxidant defense, and gene expression and also help in delaying the aging process and decreasing the risk of cancer, heart disease, high cholesterol, diabetes, osteoporosis, arthritis, insomnia, cataracts, constipation, indigestion, and several other disorders [12].

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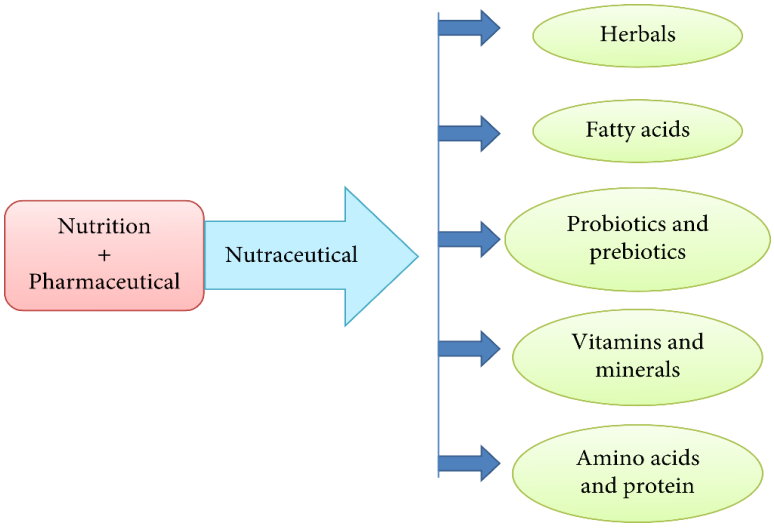


Figure 1. Properties of Neutraceuticals [13]

There is a great demand for these nutraceuticals, the global nutraceuticals market size was estimated at USD 454.55 billion in 2021 and is expected to increase at a compound annual growth rate (CAGR) of 9.0% from 2021 to 2030 according to a market survey. Different chemical compounds present in the plants are extracted as neutraceuticals like Allicin from Allium Sativum, Curcumin from Curcuma longa, and Omega 3 Fatty Acids from Linum usitatissimum, etc. [14]. The famous nutraceuticals include lutein (for macular degeneration), folic acid, cod liver oil capsules, glucosamine from ginseng, Omega-3 fatty acids from linseed, Epigallocatechin gallate from green tea, lycopene from tomato etc.. The most common food and beverage products include omega-3 eggs, omega-3-enriched yogurts, calcium-enriched orange juice, and green tea. Some popular phyto-nutraceuticals include [12,14].A few of the known marketed neutraceuticals products are: Proiteinex, Chyawanprash, Omega Woman, Coral Calcium, Calcirol D-3 etc. [11].

## 3. In Vitro Propagation Methods for Nutraceutical Plant Species

Plant secondary metabolites can be isolated from plants grown in the natural environment but with the increase in the consumption of natural products worldwide, there are difficulties in obtaining a sufficient amount of herbal raw materials [15]. Thus, in vitro propagation techniques take care of the quality aspects of species as the genetic uniformity in populations is maintained. In vitro, culture techniques are the useful tools for the production and marketing of nutraceutical species which helps in the rapid clonal propagation of plants having active principles. The importance of secondary metabolites has resulted in a great interest in the commercial production of plant chemicals using tissue culture technology [16]. Different methods of in vitro cultures like callus or cell cultures, to produce biomass of medicinal plants (adventitious regeneration of organs, organogenesis from callus, somatic embryogenesis, cultivation of genetically transformed plant material) whereas, to

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produce true-type plants, the micropropagation techniques are necessary to clone selected plants and are helpful to start field cultivation for a mass herbal production [17]. Micropropagation has been done in a diverse group of plants including nutraceuticals and has eliminated the uncertainty in developing standardized medicinal and nutraceutical plant products. It can help to multiply plants with high productivity of active principle. Through this, enough plantlets can be multiplied with reduced time and area. In vitro propagation in different nutraceutical species has been carried out by using various explants like shoot tip, axillary shoot, leaf etc. from the mother plant by adding suitable plant hormones in which optimum multiple shoot induction has been recorded. Cell suspension culture is another best method for the production of active metabolites, especially natural products, with paclitaxel from Taxus spp. being the most prominent example[18]. It can help extract plant products by increasing the extract potential; reducing toxin levels, and increasing extracts' uniformity and consistency. Many Industries and Universities have developed protocol to obtain anticancer compounds like camptothecin, taxol, vinblastine and vincristine through in vitro cell cultivation [17] . Several nutraceutical species has been propagated through all these different tissue culture techniques, Some of them are mentioned in Table 1.

**Table 1. Tissue culture studies in some of the important nutraceutical plants with their chemical composition**

| Plant species with Nutraceutical properties | Chemical Composition | References |
|---|---|---|
| Allium sativum | Alliin, Allicin | [19,20] |
| Sesamum indicum | Sesamin,Sesamolin | [21,22] |
| Moringa oleifera | Oleic acid, Beta- carotene, Quinic acid | [23,24] |
| Catharanthus roseus | Vinblastine,Vincristine | [25,26] |
| Cinchona ledgeriana | Quinine, Cinchonine | [27,28] |
| Ocimum basilicum | Linalool,Eugenol | [29,30] |
| Zingiber officinale | Zingiberene and gingerols | [31,32] |
| Gentiana kuroo | Xanthones, C-glucoxanthone | [33,34] |
| Mentha spp. | Menthol and Menthone | [35,36] |
| Glycirrhiza glabra | Glycyrrhizin and liquirtin | [37,38] |
| Curcuma longa | Curcumin | [39,40] |
| Ginkgo biloba | Ginkgolide and bilobalide | [41,42] |

The in vitro culture of plant cells and tissues under controlled conditions offers a well-founded technology platform for the production of plant natural products. The in

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vitro propagation of plants or the in vitro culture of plant organs especially roots or callus can provide plant material for producing secondary metabolites [18, 43-45]. The in vitro cultivation methods also avoid the problems related to the collection, transport, and storage of the plant products since the extraction can be carried out at regular intervals throughout the year. The protection of the natural biological balance is guaranteed because the in vitro techniques maintain the biodiversity of germplasm avoiding the environmental impact on wild species. The employment of these techniques provides bioactive molecules otherwise insufficient in nature. Because of these techniques, it is possible to carry out fast selections of cell lines in the laboratory to improve the productivity instead of the in vivo plant selection typically for the crop species which takes time for growth and development [46].

## 4. Conclusion

Thus, through Micropropagation and other tissue culture techniques in vitro plant biomass having natural compounds of nutraceutical interest can be obtained, also in vitro developed shoots could be the suitable source of bioactive compounds which will be characteristic plants of origin.

**5. Conflict of Interest:** Authors declares no conflict of interest

**6.Authors Contributions:** Each and every author had contributed to the manuscript**.** DT and AJ designed the manuscript, DT had written the content of manuscript and AJ edited the manuscript.

**Funding Info**- No funding involved.

**7.Acknowledgement** – Will like to thank Department of Botany, The MS University of Baroda, Vadodara, Gujarat for the general support.

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